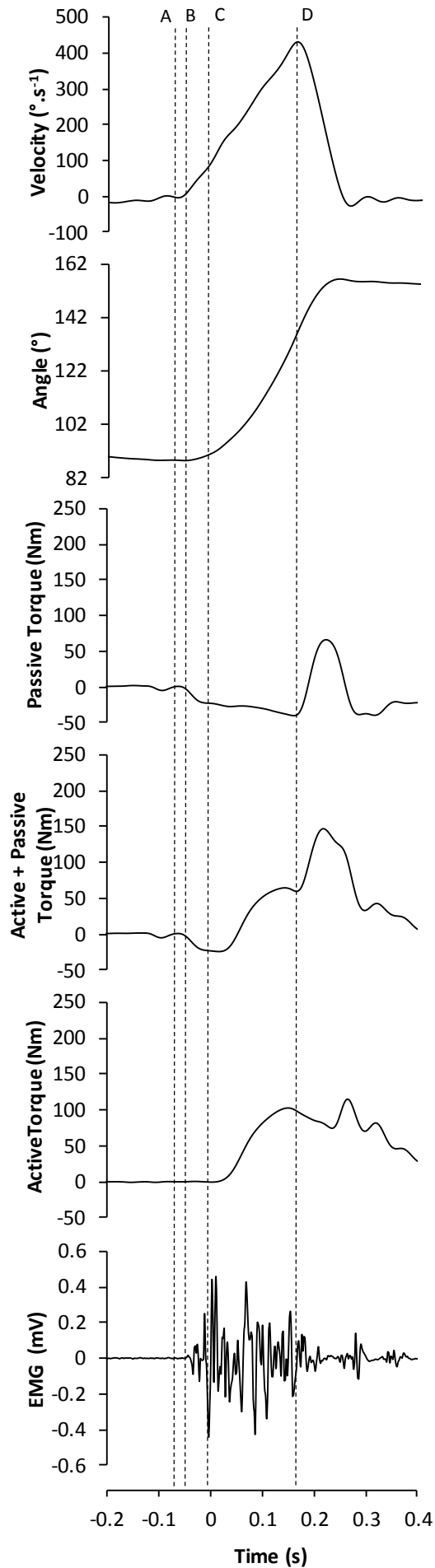


Fast Concentric



Slow Eccentric

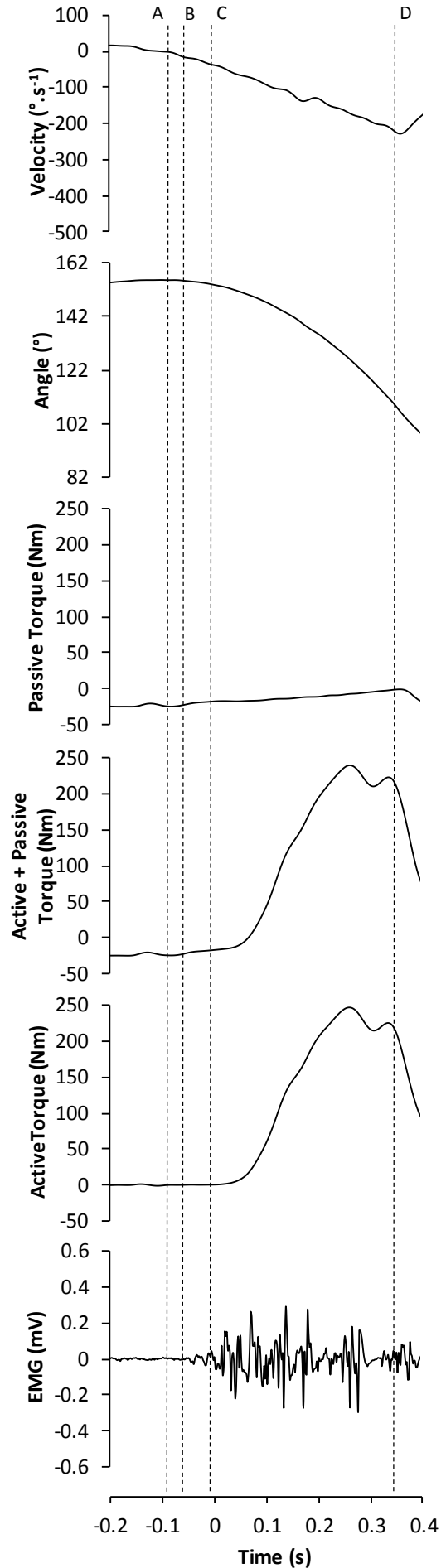


Fig. S1. Knee angular velocity, angle, extension torque, and vastus lateralis EMG data, collected during explosive voluntary contractions performed in an isokinetic dynamometer in two conditions; fast concentric (left column) and slow eccentric (right column). In each condition the crank arm accelerated at a constant $2000^{\circ}.\text{s}^{-2}$ (fast) or $-500^{\circ}.\text{s}^{-2}$ (slow) from a stationary angle (dashed line A) of 89° (concentric) or 156° (eccentric) to peak velocities (dashed line D) of $450^{\circ}.\text{s}^{-1}$ (fast) or $-225^{\circ}.\text{s}^{-1}$ (slow), before decelerating to stop at the opposite end of the range of motion. Concentric slow and eccentric fast conditions were also completed, though data is not presented here. Participants were instructed to push as “fast and hard” as possible at the start of the acceleration phase. Note, EMG onset (dashed line B) typically occurred soon after the start of the acceleration phase, and active torque onset (dashed line C) after ~ 50 ms (concentric) or ~ 70 ms (eccentric) from EMG onset. Active torque was determined by subtracting passive torque measured whilst the participant remained voluntarily passive, from the torques (active + passive) measured during the explosive voluntary contraction. Trials were only considered valid where active torque onset occurred after 20 ms of acceleration (concentric and eccentric conditions), and before 75 ms of acceleration (for fast conditions only). The 20-ms threshold was an attempt to align active onsets with those occurring during evoked involuntary contractions completed during the same conditions to assess neural efficacy. The 75-ms cut-off ensured there was a minimum of 150 ms of explosive contraction before peak velocity in the fast conditions where acceleration lasted for 225 ms. The 20 to 75-ms cut-offs also ensured similar angles but distinct velocities at active torque onset for fast and slow conditions within the same contraction type (See Table 2 in the manuscript). Data are post signal filtering and examples from only one contraction by the same participant in each condition.

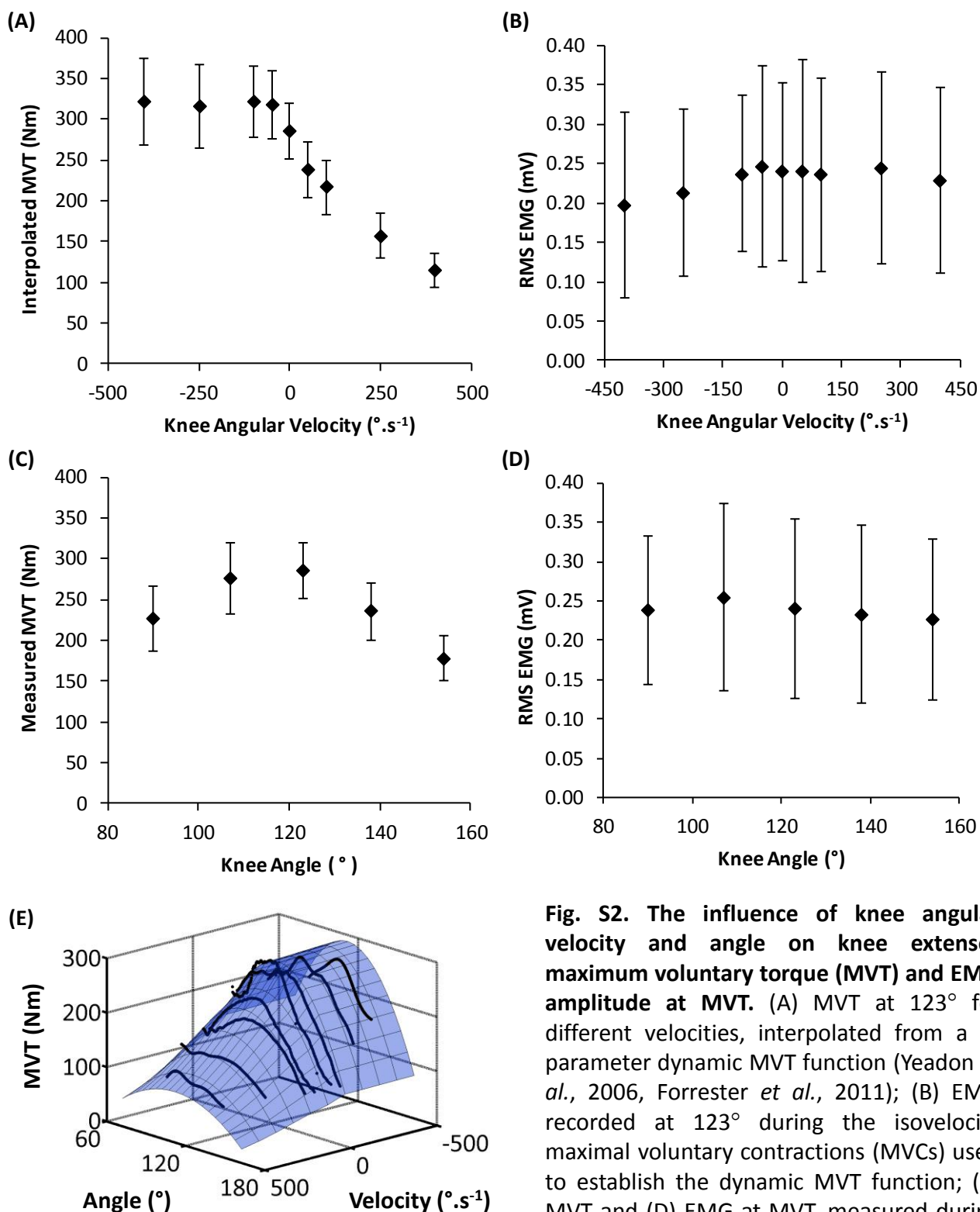


Fig. S2. The influence of knee angular velocity and angle on knee extensor maximum voluntary torque (MVT) and EMG amplitude at MVT. (A) MVT at 123° for different velocities, interpolated from a 9-parameter dynamic MVT function (Yeadon *et al.*, 2006, Forrester *et al.*, 2011); (B) EMG recorded at 123° during the isovelocity maximal voluntary contractions (MVCs) used to establish the dynamic MVT function; (C) MVT and (D) EMG at MVT, measured during isometric MVCs at different angles; (E) the dynamic MVT function (3D surface) and the measured values used to establish the function (dark dots), for one participant. Data in A-D are averaged across two separate measurement sessions before calculating the mean \pm SD for $n = 15$ (MVT) or $n = 14$ (EMG). EMG amplitudes are pre-amplification and averaged across the three superficial quadriceps muscles.

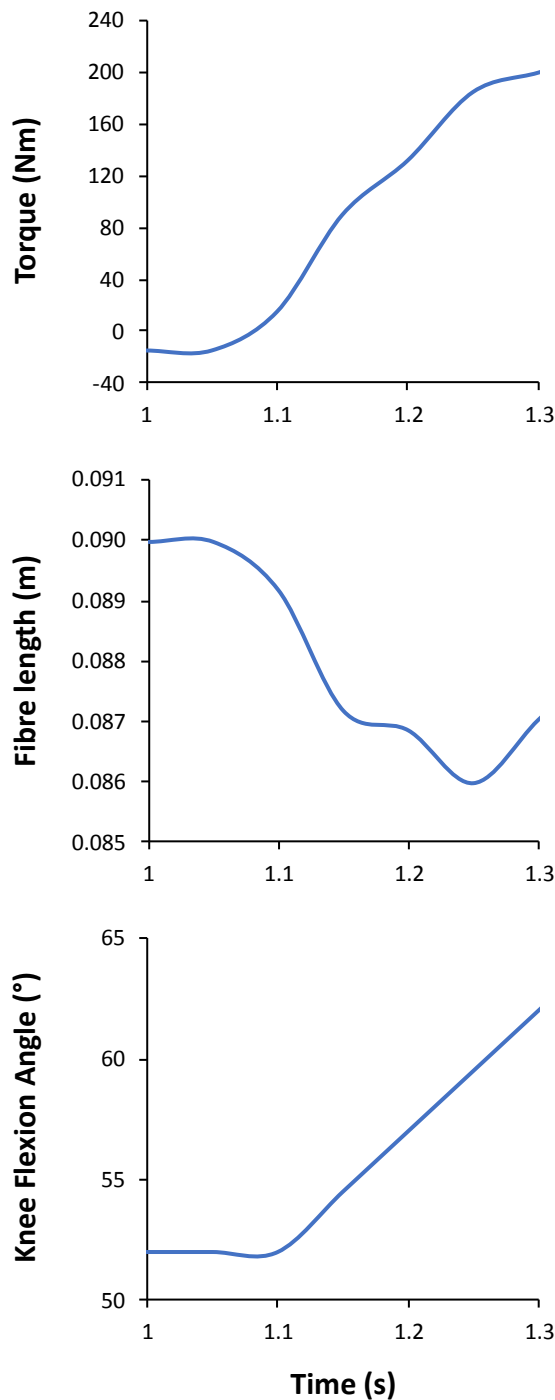


Fig. S3: Hill-Type muscle model response with different initial mechanical conditions during eccentric-type contractions. Our muscle model did not detect fibre shortening during either of the eccentric conditions in our study (Fig 3 in the manuscript), which were performed without pre-load. However, previous studies have observed muscle fibre shortening during the early phase of eccentric knee extensor contractions performed with minimal pre-load (e.g., Hahn, 2018, *Journal of Sport and Health Science*, 7:275-281). Here we show the fibre length predicted from our Hill-type muscle model using knee joint torque and angle data similar to that of Hahn (2018). We used the average of subject-specific parameters from our study (e.g., mass, height, leg length, etc). The results provide good evidence that with similar mechanical conditions to Hahn (2018), our muscle model detects fibre shortening during the early phase of an eccentric-type contraction, consistent with Hahn’s measurements. Further, the results suggest specific mechanical conditions (not present in our study) are required to elicit fibre shortening during eccentric-type contractions (see Figure 4S for suggestions).

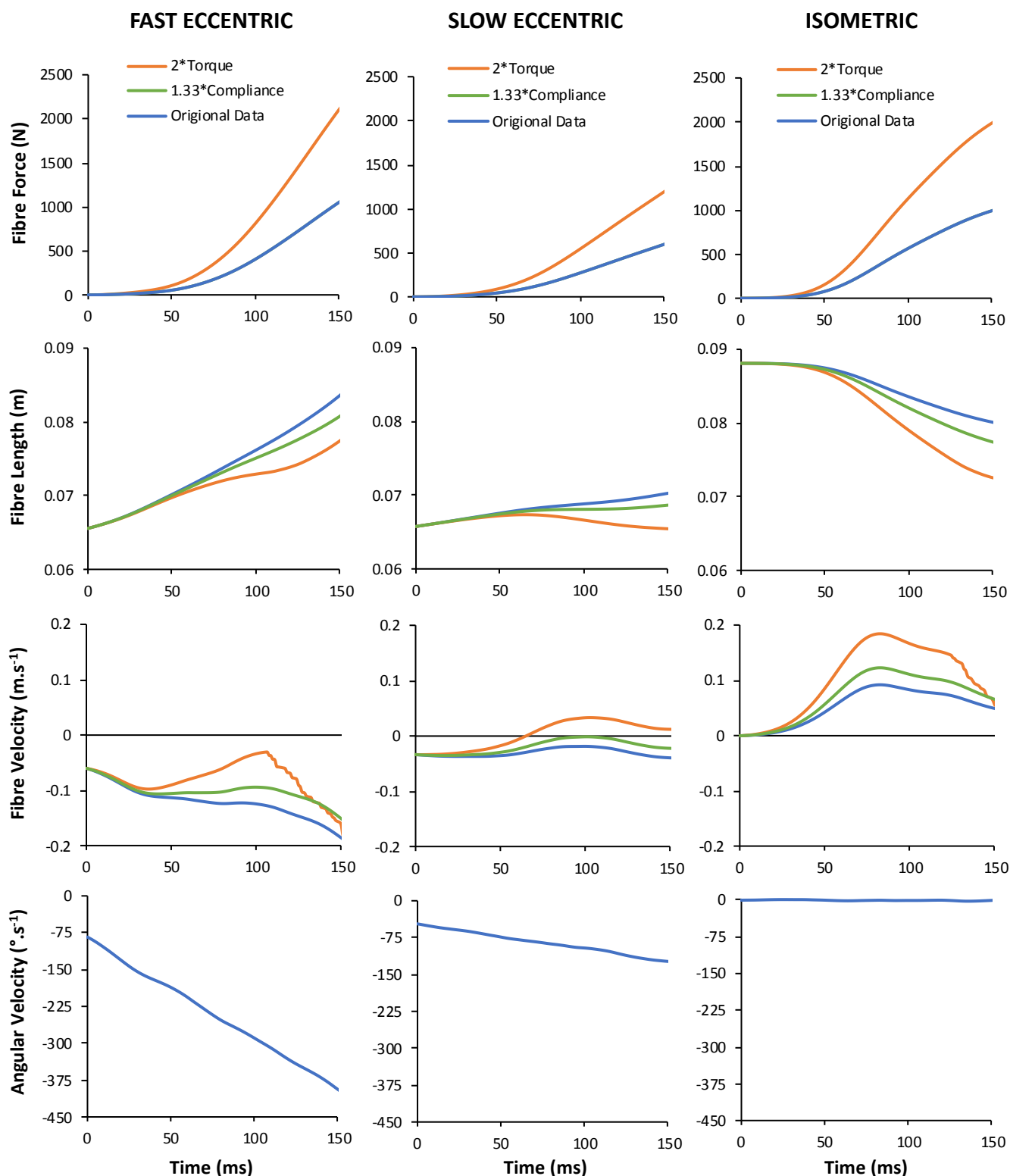


Fig. S4: The influence of joint torque production, SEC compliance, and joint angular velocity on fibre behaviour estimated by our hill type muscle model. Here we show how doubling input torques shifted fibre velocity upwards in all conditions, causing a shortening velocity after 75 ms in the eccentric slow condition. Increasing series compliance by 33% (top end of normal variability of a similar cohort; Massey et al., 2017, Exp. Physiol, 102:448-461) also shifted fibre velocity upwards in all conditions. Angular velocity, and thus the rate of MTU strain was considerably greater in the eccentric fast than eccentric slow condition, which would explain why fibre lengthening velocity in the eccentric fast condition did not get close to positive (unlike the eccentric slow condition) when torque or compliance were increased. These results show that increasing torque input or SEC compliance had similar effects on all conditions (including the concentrics, though not presented). Furthermore, fibre shortening can occur during eccentric-type contractions but only when torque and/or SEC compliance are sufficiently high, and/or when MTU strain rate is sufficiently low. Data are mean of the four quadriceps heads for n = 15.